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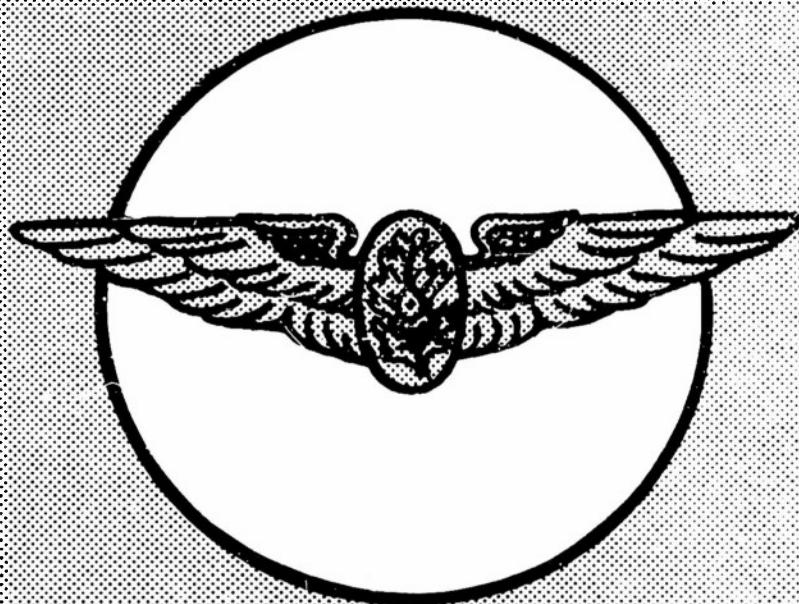
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RECOGNITION OF INTELLIGIBILITY TEST MATERIALS
IN CONTEXT AND IN ISOLATION

PROJECT NUMBER NM 001 064.01.23



RESEARCH REPORT

OF THE

U. S. NAVAL SCHOOL OF AVIATION MEDICINE

NAVAL AIR STATION
PENSACOLA FLORIDA

U. S. NAVAL SCHOOL OF AVIATION MEDICINE
NAVAL AIR STATION
PENSACOLA, FLORIDA

JOINT PROJECT REPORT NO. 23

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RECOGNITION OF INTELLIGIBILITY TEST MATERIALS IN CONTEXT AND IN ISOLATION

SUMMARY

Thirty-nine experimental subjects listened to 50 sentences and 291 words. The sentences were part of a standard sentence intelligibility test, and the words were taken out of the context of these same sentences. These materials were presented at five speech-to-noise ratios: -12 db, -6 db, 0 db, +6 db, and +12 db. Comparisons were made of the recognition of the words in context and in isolation. It was found that the intelligibility scores for the isolated words tended to be lower than for the same words in context. The lowest intelligibility scores occurred at -12 db and 0 db speech-to-noise ratios.

INTRODUCTION

Miller, Heise, and Lichten (4), in an investigation of the effects of context and isolation on the relative recognition of intelligibility-test items, found that when words from a specific vocabulary were taken out of context and arranged in random order they became more difficult to recognize aurally. The investigation employed the Harvard SI-lists which were developed during the 1940's for use in evaluating communication networks (2). Earlier, Egan (2) investigated the relationship between sentence and word intelligibility scores and reported that at the sound pressure level at which listeners were able to recognize correctly 80 per cent of a sentence test, they were able to recognize correctly only 50 per cent of a word test.

The purpose of the present study was to extend the type of study of Miller, Heise, and Lichten, who had used two experienced listeners, and to determine whether or not the results of their study obtained with another type of sentence intelligibility test and an inexperienced experimental population.

PROCEDURE

Thirty-nine Naval Aviation Cadets enrolled in pre-flight training (NAS, Pensacola, Florida) served as experimental subjects. There were three panels of listeners with 13 members per panel.

Fifty sentences that were originally items in a short-answer intelligibility test were employed as write-down test items. This test was developed by Haagen at the Waco Voice Communication Labora-

tory (1) and included paraphrases of items from low-age intelligence tests, other short-answer intelligibility tests, and original items. As Haagen employed the sentences, listeners responded by writing down answers to the test questions and, on the basis of this procedure, the lists were of equal difficulty. In the present instance, listeners wrote as much of each sentence as they heard. The 50 sentences were divided into five groups of 10 sentences, and the groups were presented at different speech-to-noise ratios.

Selected key words from the sentences were assembled into a word-recognition test. These test items consisted of all words in the sentences with the exception of prepositions, connectives, and possessive adjectives; the words were taken out of context, randomized, and presented as single items. Each word was used but once; there was a total of 291 words. They were distributed into five sections corresponding to the sentence groupings from which they were drawn. The sections consisted of (a) 76 words, (b) 51 words, (c) 54 words, (d) 56 words, and (e) 54 words. The phonetic equality or inequality of the words was disregarded. There were 156 monosyllables, 98 dissyllables, 31 trisyllables, and six words of more than three syllables. The syllabic composition of the words in each section was as follows: (a) 55 monosyllables, 18 disyllables, 3 trisyllables; (b) 23 monosyllables, 16 dissyllables, 10 trisyllables, and 2 of more than three syllables; (c) 26 monosyllables, 20 dissyllables, 5 trisyllables, and 3 of more than three syllables; (d) 24 monosyllables, 22 dissyllables, 9 trisyllables, and 1 of more than three syllables; and (e) 28 monosyllables, 22 dissyllables, and 4 trisyllables.

Each section of the word test, a,b ... e, was presented at a speech-to-noise ratio that corresponded to the ratios when the same items were presented in a contextual setting.

One male speaker recorded the test materials with an Altec 21-B microphone feeding an Ampex 400 tape recorder. The recordings were played back to the listening panels through a high-quality listening circuit. Each subject wore a pair of PDR-8 earphones, mounted in doughnut cushions.

The test materials were delivered to the subjects at a reference voltage level (measured at the earphones) that yielded an acoustic level of 105 db, re .0002 dynes/cm². The listeners were simultaneously exposed to free field, recorded aircraft noise. The level of the noise, as measured under the earphones, was 105 db, re .0002 dynes/cm². Thus, at the reference level, there was an approximate speech-to-noise ratio of 0 db. From this reference level, four

other speech-to-noise ratios were established: -12 db, -6 db, +6 db, and +12 db. The speech-to-noise ratio was set by varying the signal level relative to the constant noise level. Subjects recorded their responses on write-down answer sheets.

RESULTS AND DISCUSSION

The two sets of scores that were obtained under the various speech-to-noise ratios in this study are plotted in Figure 1 along with comparable scores reported by Miller, Heise, and Lichten.

Miller, Heise, and Lichten reported thresholds (50 per cent intelligibility) of +4 db signal-to-noise ratio for words in isolation and -2 db for words in sequential context. In the present study the comparable thresholds were +4 and -3 db signal-to-noise ratio. Apparently both experiments evaluated a rather "stable" phenomenon. Comparable results were obtained here with an entirely different vocabulary and a larger, untrained group of listeners. In view of the similarity of the threshold values in the two studies certain comparisons of the relative intelligibility scores of the two studies may be justified.

In the instance of intelligibility scores in context, the difference in the results of the two studies was small, the major difference occurring at the -6 db speech-to-noise ratio and amounting to about three per cent intelligibility. The higher score was obtained in the earlier study.

The two sets of scores for words in isolation were markedly different at the -6 db speech-to-noise ratio. Miller, Heise, and Lichten found an intelligibility value of about 28 per cent at this level, approximately 15.5 per cent greater than the present score. At other speech-to-noise ratios, the two sets of scores did not differ by more than six per cent.

Aside from a comparison of the results of two related studies, a principal interest lies in comparing the scores of words in context and in isolation. These mean values are enumerated in Table 1. The values of Table 1 and the plots of Figure 1 reveal that context contributed little to intelligibility at the -12 db speech-to-noise ratio, *viz.* two per cent. At the four more favorable signal-to-noise ratios the differences ranged from 19 to 26 per cent. Whereas Miller, Heise, and Lichten report only a six per cent advantage of context over isolated words at the -6 db speech-to-noise ratio, the present value was approximately 23.5 per cent, a difference apparently attributable to the relatively low score obtained at this level for words in isolation in the present study. With more favorable speech-to-noise ratios than -6 db, context contributed at least a 20 per cent increase in intelligibility score. These results are in agreement with Egan's findings (2).

The differences between the scores of words in context and isolation at the various signal-to-noise ratios were tested for significance by a series of t-tests. The results are summarized in Table 1 and indicate that there were significant differences between the sets of values in all instances except at -12 db signal-to-noise ratio. The maximum advantage of context over isolation occurred at zero db speech-to-noise ratio.

The stability of the intelligibility scores of individual words was a further concern in this study. If the score for a word is a reliable measure for a single condition of signal vs. noise, this fact would be expected to affect positively a measure of correlation between two sets of values for the same words. Item intelligibility values were computed for the words in context and in isolation. These values were correlated and the values of r are enumerated in Table 2 along with the means and standard deviations. The obtained r's indicate no significant relationship between the two sets of values at three of the speech-to-noise ratios. The observed r's for the -12 db and 0 db speech-to-noise ratios were significant beyond the one per cent level of confidence. Apparently, at three of the speech-to-noise ratios, the relative intelligibility of a word in either context or isolation was not predictive of its intelligibility in the other circumstance. An inspection of the scores of Table 2 indicates that random association (lack of correlation) increases as the speech-to-noise ratio becomes more favorable. This fact is less surprising, in view of the decrease in variance within a list as the signal-to-noise ratio improves, than is the fact that at the 0 and -12 db signal-to-noise ratios the values of the correlation are barely significant and, at -6 db, nonsignificant. Apparently, words have context intelligibility values as well as isolation intelligibility values and with this accepted, the possibility arises that various uncontrolled features of context may affect the intelligibility value of a word differentially.

CONCLUSION

Intelligibility scores for isolated words tend to be lower than when the words are presented in context. This difference amounts to 19-26 per cent for speech-to-noise ratios of -6 db, 0 db, +6 db, and +12 db. These results are consistent with the findings of Miller, Heise, and Lichten.

Apparently the intelligibility scores that were obtained for each grouping of words (context and isolation) were not due to the same words being recognized with a similar relative frequency under the two conditions. The least random responses in this regard occurred at the -12 db and 0 db speech-to-noise ratios. These are apparently the points at which a correct response would have the greatest predictive value.

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TABLE 1

Isolation means, context means, mean differences and
t tests of significance of difference between words
in context and words in isolation.

	Isolation Mean	Context Mean	Context Mean minus Isolation Mean	<u>t</u>
-12 db S/N ratio	1.97	2.90	.08	.57
-6 db S/N ratio	5.63	14.98	9.35	7.79*
0 db S/N ratio	16.22	29.48	13.26	8.96*
+6 db S/N ratio	28.82	37.57	8.75	5.46*
+12 db S/N ratio	32.56	40.76	8.20	5.03*

*t significant at the .01 level of confidence.

TABLE 2

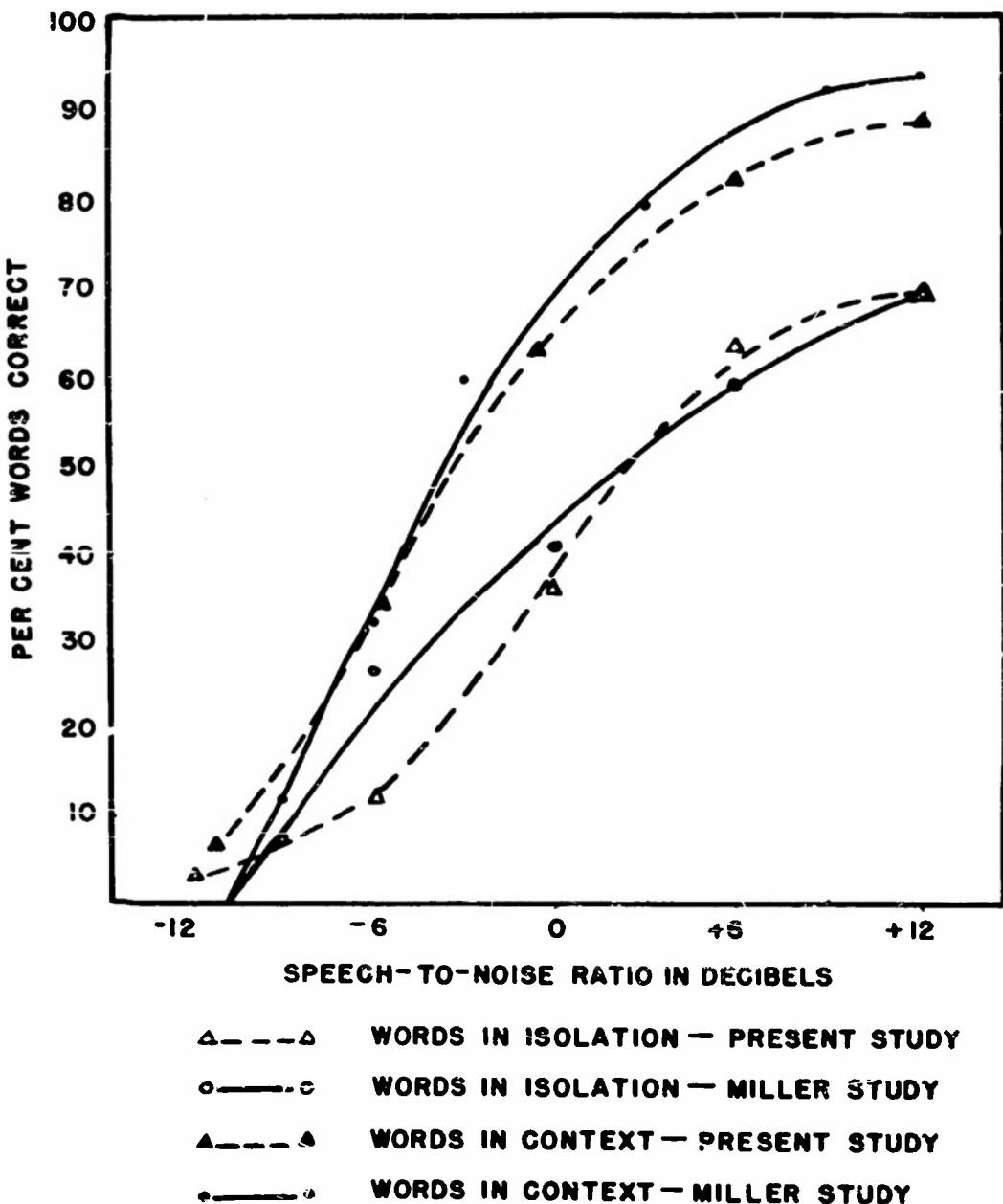
Mean correct scores, their standard deviations and the product-moment correlations between the intelligibility values of words in context and the same words in isolation at 5 different speech-to-noise ratios.

Speech-to-Noise Ratio

	-12 db	-6 db	0 db	+6 db	+12 db
Number of Words	76	51	54	56	54
In isolation					
Mean	2.97	6.47	16.09	28.21	32.31
S.D.	2.93	4.98	11.05	11.98	12.78
In context					
Mean	4.05	16.25	29.48	37.57	40.80
S.D.	3.63	7.79	8.79	9.15	11.77
r	.42*	.24	.42*	.04	.09

*P less than 0.01

FIGURE 1
PLOTTING OF INTELLIGIBILITY SCORES FOR
WORDS IN CONTEXT AND ISOLATION



U. S. Naval School of Aviation Medicine, Pensacola, Florida 15 June 1974

Joint Project Report #100 06A.01.23

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John J. O'Neill, Acoustic Laboratory, The Ohio State University and U. S. Naval School of Aviation Medicine, Pensacola, Florida.

5 pp. 2 tables 1 illustration UNCLASSIFIED

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2. Acoustics
3. Measurement--Speech
4. U.S. Naval School of Aviation Medicine

I. O'Neill, John J.

(L.C. Subj. Head.)

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